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[Title of the Invention]	TRANSMISSION POWER CONTROL METHOD AND TRANSMISSION/RECEPTION APPARATUS
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[NAME OF DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] TRANSMISSION POWER CONTROL METHOD AND TRANSMISSION/RECEPTION APPARATUS

[SCOPE OF CLAIMS FOR PATENT]

[Claim 1] A transmission power control method, wherein first transmission power control is performed according to a transmission power control signal mixed into the reception signal, and if a base station is far from a mobile station, second transmission power control is performed to reduce the transmission power.

[Claim 2] The transmission power control method according to claim 1, wherein the distance estimation in the second transmission power control is performed by estimating the reception quality of said received uplink signal or downlink signal, and if the estimated reception quality is low, the transmission power to the communication destination is reduced.

[Claim 3] The transmission power control method according to claim 1, wherein the distance estimation in the second transmission power control is performed by measuring the reception power of said received uplink signal or downlink signal, and if the measured reception power is low, the transmission power to the communication destination is reduced.

[Claim 4] The transmission power control method according to claim 1, wherein the distance estimation in the second transmission power control is performed by measuring the time difference between the reception

timing of the reception signal and the transmission timing of the transmission signal, and if the measured time difference is large, the transmission power to the communication destination is reduced.

[Claim 5] A handover control method, wherein the total amount of transmission power during a handover is suppressed by using the transmission power control method described in any one of claim 1 to claim 4 during the handover.

[Claim 6] A transmission/reception apparatus comprising:

first transmission power control means for carrying out transmission power control between a mobile station and base station according to a transmission power control signal mixed into a reception signal;

reception quality estimation means for estimating the reception quality of the reception signal; and

second transmission power control means for carrying out transmission power control to reduce the transmission power to said communication destination when said estimated reception quality is low.

[Claim 7] A transmission/reception apparatus comprising:

first transmission power control means for carrying out transmission power control between a mobile station and base station according to a transmission power control signal mixed into a reception signal;

reception power measuring means for measuring the

reception power of the reception signal; and

second transmission power control means for carrying out transmission power control to reduce the transmission power to said communication destination when said measured reception power is low.

[Claim 8] A transmission/reception apparatus comprising:

first transmission power control means for carrying out transmission power control between a mobile station and base station according to a transmission power control signal mixed into a reception signal;

time difference measuring means for measuring a time difference between the reception timing of the reception signal and transmission timing of the transmission signal; and

second transmission power control means for carrying out transmission power control to reduce the transmission power to said communication destination when said measured time difference is large.

[Claim 9] The transmission/reception apparatus described in any one of claim 6 to claim 8, wherein transmission power control by said first transmission power control means and second transmission power control means is carried out by a single amplifier and at the same time a reduction of transmission power by said second transmission power control means is carried out by adjusting the offset value of said amplifier.

[Claim 10] A base station, wherein transmission

power control is carried out by the base station described in any one of claim 6 to claim 9 when a handover takes place.

[Claim 11] A mobile station, wherein transmission power is increased only when both a transmission power control signal received from a base station according to claim 10, the origin of movement when a handover takes place, and a transmission power control signal received from another base station according to claim 10, the destination of movement contain commands to increase transmission power.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field of the Invention]

The present invention relates to a transmission power control method and a transmission/reception apparatus to carry out CDMA communications. To be more specific, the present invention relates to a transmission power control method and a transmission/reception apparatus that optimally control the transmission power of the base station before and after a move when a soft handover takes place.

[0002]

[Prior Art]

A conventional transmission/reception apparatus carrying out handover control has a configuration shown below. FIG.6 are block diagrams showing an outline of conventional transmission/reception apparatus of mobile

station side, and transmission/reception apparatus of base station A and base station B side.

[0003]

The transmission/reception apparatus M of mobile station side comprises mobile station frame formatter 601, mobile station spreader 602, mobile station modulator 603, mobile station amplifier 604, mobile station duplexer 605, mobile station antenna 606, mobile station integrator 607, mobile station demodulator 608, mobile station despreader 609, mobile station RAKE combiner 610, mobile station SIR measurer 611 and mobile station AND operator 612.

[0004]

On the other hand, transmission/reception apparatus which constitutes base station A comprises base station A frame formatter 613, base station A spreader 614, base station A modulator 615, base station A amplifier 616, base station A duplexer 617, base station A antenna 618, base station A integrator 619, base station A demodulator 620, base station A despreader 621, base station A SIR measurer 622 and base station A RAKE combiner 23.

[0005]

Likewise, transmission/reception apparatus which constitutes base station B comprises base station B frame formatter 624, base station B spreader 625, base station B modulator 626, base station B amplifier 627, base station B duplexer 628, base station B antenna 629, base station B integrator 630, base station B demodulator 631, base

station B despreader 632, base station B SIR measurer 633 and base station B RAKE combiner 634.

[0006]

In communication according to the transmission/reception apparatus configured as shown above carry out a handover as shown in FIG.7 to FIG.10. FIG.7 is a schematic diagram showing how a handover takes place, FIG.8 shows the reception power of the mobile station without transmission power control, FIG.9 shows the transmission power of the base stations with transmission power control and FIG.10 shows the reception power of the mobile station carrying out transmission power control using conventional transmission/reception apparatuses.

[0007]

As shown in FIG.7, handover control is required when mobile station M moves from the area of base station A within the reach of radio waves of base station A to the area of base station B within the reach of radio waves of base station B. At this time, mobile station M must switch a communication with base station A to one with base station B. In this case, CDMA communications, etc. allow the mobile station to use a same frequency in neighboring areas, making a so-called soft handover possible, which is a way of realizing a seamless handover in a soft manner.

[0008]

When carrying out a handover, mobile station M

receives reception power R1 (NPC.RA) with which the mobile station receives a signal transmitted from base station A without transmission power control and reception power R2 (NPC.RB) with which the mobile station receives another signal transmitted from base station B without transmission power control, and combines both R1 and R2. FIG.8 shows how this combination takes place. As shown in FIG.8, mobile station M combines reception power R1 (NPC.RA) and reception power R2 (NPC.RB) into reception power R3 (NPC.RC). Through such a combination of reception signals, mobile station M can receive a signal with combined reception power R3 (NPC.RC) with a quality exceeding the required level even on the cell boundary distant from both base stations.

[0009]

However, since the two base stations above do not carry out downlink transmission power control. This causes combined reception power R3 (NPC.RC) of mobile station M to have an excessive quality exceeding the desired quality when mobile station M is near either base station A or base station B as shown in FIG.8. The right and left ends of combined reception power R3 in FIG.8 show this situation. Thus, if the reception levels at the start and end of a handover have an excessive quality, signals transmitted from the base station to the mobile station may not only cause interference with communications of other users but also suppress the system capacity.

[0010]

For this reason, the base stations need to perform downlink transmission power control. That is, mobile station M sends transmission power control signals to base station A and base station B. Based on the transmitted base station control signals, base station A controls transmission power T1 (CPC.TA) and base station B controls transmission power T2 (CPC.TB). That is, transmission power T1 (CPC.TA) of base station A is controlled to be lower near base station A and transmission power T2 (CPC.TB) of base station B is controlled to be lower near base station B. FIG.9 shows this situation.

[0011]

By carrying out such transmission power control, reception power R1'(CPC.RA) at mobile station M of a signal transmitted by base station A and reception power R2'(CPC-RB) at mobile station M of another signal transmitted by base station B together constitute reception power R3' shown in FIG.10. Thus, by combining signals received from two base stations, combined reception power R3'(CPC.RC) at the mobile station matches the desired quality, making it possible to suppress excessive transmission power from the base stations and improve the system capacity.

[0012]

A conventional CDMA transmission system carrying out downlink transmission power control when mobile station M carries out a soft handover from the area of

base station A to the area of base station B is explained in detail with reference to FIG.6.

[0013]

Mobile station M sends TX_DATA_U1, an uplink transmission signal, to the base stations. Mobile station M carries out error correction coding on transmission signal TX_DATA_U1 by frame formatter 601. At the same time, mobile station M inserts a pilot symbol and transmission power control signal TPC_DM for a downlink signal determined based on the result of SIR measurer 611 that estimates the quality of the downlink signal. Further, mobile station M spreads the output of frame formatter 1 by spreader 602, modulates by modulator 603, amplifies by amplifier 604, and then sends it from antenna 606 via duplexer 605. At this time, the amplification factor of amplifier 604 is controlled by the output of integrator 607.

[0014]

On the other hand, base station A inputs the signal received from antenna 618 via duplexer 617, demodulates by demodulator 620, processes by despreader 621 and RAKE combiner 623 and obtains reception signal RX_DATA_UA. Then, base station A estimates the reception quality of the uplink signal by SIR measurer 622 using the result of RAKE combiner 623 and determines the transmission power control level of the uplink signal based on this estimated value TPC_UBA. Frame formatter 613 inserts a pilot signal and uplink signal transmission power control bit TPC_UBA

into downlink signal TX_DATA_D subjected to error correction coding. Base station A spreads this signal by spreader 614, modulates by modulator 615, amplifies by amplifier 616 and transmits it from antenna 618 via duplexer 617. The amplification factor then is determined by a value obtained by integrator 619 integrating downlink transmission power control signal TPC_DBA which was extracted by RAKE combiner 623. By the way, downlink transmission power control signal TPC_DBA used at this time is the demodulated TPC_DM that was inserted into the uplink signal by the mobile station. This is how base station A performs downlink transmission power control.

[0015]

Likewise, base station B inputs the signal received from antenna 629 via duplexer 628, demodulates by demodulator 631, processes by despreader 632 and RAKE combiner 634 and obtains reception signal RX_DATA_UB. At this time, base station B estimates the reception quality of the uplink signal by SIR measurer 633 using the result of RAKE combiner 634 and determines the transmission power control level of the unlink signal based on this estimated value TPC_UBB. Frame formatter 624 inserts a pilot signal and uplink signal transmission power control bit TPC_UBB into downlink signal TX_DATA_D subjected to error correction coding. TX_DATA_D is the same as TX_DATA_D of base station A. Base station B spreads this signal by spreader 625, modulates by

modulator 626, amplifies by amplifier 627 and transmits it from antenna 629 via duplexer 628. The amplification factor then is determined by a value obtained by integrator 630 integrating downlink transmission power control signal TPC_DBB which was extracted by RAKE combiner 634. Downlink transmission power control signal TPC_DBB used at this time is the demodulated TPC_DM that was inserted into the uplink signal by the mobile station. This is how base station B performs downlink transmission power control.

[0016]

If there are no demodulation errors, TPC_DBA and TPC_DBB are the same, and therefore the same amplification factor of the downlink signal is used for base station A and base station B, hence the same increment/decrement control is performed. However, since their initial values of amplification factor are not always the same, the absolute values of amplification factor are not always the same.

[0017]

Mobile station M demodulates the signal received from antenna 606 via duplexer 605 by demodulator 608 and obtains received data RX_DATA_D via despreader 609 and RAKE combiner 610. Furthermore, mobile station M estimates the quality of the downlink reception signal by SIR measurer 611 using the result of RAKE combiner 610 and determines downlink signal transmission power control bit TPC_DM based on this estimated value.

Transmission power control of the downlink signal above is performed according to this signal. RAKE combiner 610 extracts the uplink transmission power control signals inserted into both the downlink signal from base station A and the uplink signal from base station B. TPC_UMA is the extracted TPC_UBA that was inserted by base station A and TPC_UMB is the extracted TPC_UBB that was inserted by base station B.

[0018]

Transmission power signals TPC_UBA and TPC_UBB have different values, but the transmission power of the uplink signal is increased only when both TPC_UMA and TPC_UMB have control to increase the transmission power through AND operator 612. Otherwise, mobile station M determines TPC_UM, an input signal to integrator 607 so that the transmission power of the uplink signal is reduced. This prevents the uplink signal from having excessive transmission power at the time of a soft handover.

[0019]

As shown above, the conventional transmission/reception apparatus performs transmission power control for both the uplink signal and downlink signal at the time of a soft handover, which suppresses excessive transmission power within a certain range, preventing the system capacity from reducing.

[0020]

[Problems to be Solved by the Invention]

However, in the conventional

transmission/reception apparatus above, mobile station M inserts the same downlink signal transmission power control bit for both base station A that stays in the handover source area and base station B that stays in the handover destination area, and thus performs the same transmission power control. That is, although contributions of the reception signal from base station A and the reception signal from base station B to a combined reception signal at mobile station M are different at the beginning and at the end of the handover, both base station send signals with the same transmission power over the entire handover period. As a result, the transmission power at the beginning and at the end of the handover may constitute interference with other users and suppress the capacity of the communication system.

[0021]

The present invention has been made in consideration of the above-mentioned problem, and an objective of the present invention is to provide a transmission power control method and a transmission/reception apparatus capable of improving the system capacity by preventing transmissions with excessive transmission power during a soft handover and reducing total transmission power of the system while maintaining the reception quality at the receiving station.

[0022]

[Means for Solving the Problems]

In order to solve the above-mentioned problems, the

present invention uses the following means.

[0023]

The invention of the transmission power control method described in claim 1 adopts a method, wherein first transmission power control is performed according to a transmission power control signal mixed into the reception signal, and if a base station is far from a mobile station, second transmission power control is performed to reduce the transmission power.

[0024]

By this configuration, transmission power is made to reduce if a base station is far from a mobile station, whereby transmission is not executed in excessive transmission power, and the total transmission power of the system decreases, whereas the system capacity and transmission quality increase.

[0025]

In this case, the distance estimation in the second transmission power control is appropriately performed by estimating the reception quality of said received uplink signal or downlink signal as the invention described in claim 2, the distance estimation in the second transmission power control is performed by measuring the reception power of said received uplink signal or downlink signal as the invention described in claim 3, or the distance estimation in the second transmission power control is performed by measuring the time difference between the reception timing of the reception signal and

the transmission timing of the transmission signal as the invention described in claim 4.

[0026]

Also, the invention of the handover control method described in claim 5, adopts a method wherein, the total amount of transmission power during a handover is suppressed by using the transmission power control method described in any one of claim 1 to claim 4 during the handover.

[0027]

By this method, when the mobile station moves between cells, total transmission power of transmission power of both origin of movement and destination of movement is made to reduce, thus it is possible to improve capacity of system.

[0028]

The invention of the transmission/reception apparatus described in claim 6 adopts a configuration comprising first transmission power control means for carrying out transmission power control between a mobile station and base station according to a transmission power control signal mixed into a reception signal, reception quality estimation means for estimating the reception quality of the reception signal, and second transmission power control means for carrying out transmission power control to reduce the transmission power to the communication destination when the estimated reception quality is low.

[0029]

The invention of the transmission/reception apparatus described in claim 7 adopts a configuration comprising first transmission power control means for carrying out transmission power control between a mobile station and base station according to a transmission power control signal mixed into a reception signal, reception power measuring means for measuring the reception power of the reception signal, and second transmission power control means for carrying out transmission power control to reduce the transmission power to the communication destination when the measured reception power is low.

[0030]

The invention of the transmission/reception apparatus described in claim 8 adopts a configuration comprising first transmission power control means for carrying out transmission power control between a mobile station and base station according to a transmission power control signal mixed into a reception signal, time difference measuring means for measuring a time difference between the reception timing of the reception signal and transmission timing of the transmission signal, and second transmission power control means for carrying out transmission power control to reduce the transmission power to the communication destination when the measured time difference is large.

[0031]

By these configurations, when distance is far from

the communication partner, transmission power is made to reduce, whereby transmission with excessive transmission power is not executed, thus reception quality of reception station is maintained effectively and total transmission power of system is reduced, with the result that it is possible to improve capacity of system.

[0032]

The invention of the transmission/reception apparatus described in claim 9 adopts a configuration, wherein transmission power control by said first transmission power control means and second transmission power control means is carried out by a single amplifier and at the same time a reduction of transmission power by the second transmission power control means is carried out by adjusting the offset value of the amplifier.

[0033]

By this configuration, it is possible to execute transmission power control by the second transmission power control means without changing the first transmission power control means, and it is also possible to realize easily control of being reflected two kinds of transmission power control.

[0034]

The invention of the base station described in claim 10 adopts a configuration, wherein transmission power control is carried out by the base station described in any one of claim 6 to claim 9 when a handover takes place.

[0035]

Thus, base stations of both origin of movement and destination of movement are made to execute above-described transmission power control at the time handover is executed, so, it is possible to reduce total transmission power of the transmission power and to execute improvement of capacity of system.

[0036]

The invention of the mobile station described in claim 11 adopts a configuration, wherein transmission power is increased only when both a transmission power control signal received from a base station according to claim 10, the origin of movement when a handover takes place, and a transmission power control signal received from another base station according to claim 10, the destination of movement contain commands to increase transmission power.

[0037]

By this configuration, in cases where both distances from respective base stations are different at starting time of soft handover and end time thereof, it is possible to avoid situation in which transmission power is raised in accordance with transmission power control signal farer distance base station, thus farer distance base station's transmission power control becomes predominant, and transmission for the base station with excessive transmission power is not executed, whereby reception quality of reception station is maintained effectively

and total transmission power of system is reduced, thus it is possible to execute improvement of capacity of system.

[0038]

[Embodiments of the Invention]

(Embodiment 1)

With reference now to the attached drawings, a CDMA base station according to Embodiment 1 of the present invention is explained below. FIG.1 are block diagrams showing an outlined configuration of a system including transmission/reception apparatus according to Embodiment 1 of the present invention.

[0039]

Transmission/reception apparatus M of mobile station comprises mobile station frame formatter 101, mobile station spreader 102, mobile station modulator 103, mobile station amplifier 104, mobile station duplexer 105, mobile station antenna 106, mobile station integrator 107, mobile station demodulator 108, mobile station despreader 109, mobile station RAKE combiner 110, mobile station SIR measurer 111 and mobile station AND operator 112.

[0040]

On the other hand, transmission/reception apparatus which constitutes base station A comprises base station A frame formatter 113, base station A spreader 114, base station A modulator 115, base station A amplifier 116, base station A duplexer 117, base station A antenna 118,

base station A integrator 119, base station A demodulator 120, base station A despreader 121, base station A SIR measurer 122 and base station A RAKE combiner 123, and further base station A offset adjuster 135.

[0041]

Likewise, transmission/reception apparatus which constitutes base station B comprises base station B frame formatter 124, base station B spreader 125, base station B modulator 121, base station B amplifier 127, base station B duplexer 128, base station B antenna 129, base station B integrator 130, base station B demodulator 131, base station B despreader 132, base station B SIR measurer 133 and base station B RAKE combiner 134, and further base station B offset adjuster 136.

[0042]

Transmission/reception apparatus of the present invention is that base station A offset adjuster 135 and base station B offset adjuster 136 are added to respective conventional fundamental configurations. Offset adjusters 135 and 136 have a function to adjust offset values of the amplification factors of amplifiers 116 and 117. In Embodiment 1, offset adjuster 135 at base station A controls the amplification factor taking into account both a value obtained by integrator 119 integrating the output from RAKE combiner 123 and the quality of the uplink signal estimated by SIR measurer 122. Likewise, offset adjuster 136 at base station B controls the amplification factor taking into account

both a value obtained by integrator 130 integrating the output from RAKE combiner 134 and the quality of the uplink signal estimated by SIR measurer 133.

[0043]

The transmission power control processing when a handover is carried out by base stations A and B above is explained in detail with reference to FIG.2 and FIG.3. FIG.2 is a schematic diagram of the transmission power of the base station of Embodiment 1 of the present invention and FIG.3 is a drawing showing the reception power level of mobile station M of Embodiment 1 of the present invention. In Embodiment 1, suppose a soft handover takes places when mobile station M moves from the area of base station A to the area of base station B.

[0044]

Mobile station M sends uplink signal TX_DATA_U1. First, frame formatter 101 carries out error correction coding on the transmission data, inserts a pilot symbol and inserts downlink signal transmission power control signal TPC_DM determined based on the result of SIR measurer 111 that estimates the quality of the downlink signal. The output signal of this frame formatter 101 is spread by spreader 102, modulated by modulator 103, amplified by amplifier 104 and transmitted from antenna 106 via duplexer 105. The amplification factor of amplifier 104 is controlled by integrator 107.

[0045]

Base station A separates the signal received from

antenna 118 by duplexer 117, demodulates by demodulator 120, subjects to signal processing by despreader 121 and RAKE combiner 123 and obtains reception signal RX_DATA_UA. At this time, SIR measurer 122 estimates the reception quality of the uplink signal using the output of RAKE combiner 123 and determines the transmission power control level of the uplink signal based on estimated value TPC_UBA. The determined transmission power control level is inserted into downlink transmission signal TX_DATA_D as a transmission power control bit by frame formatter 113. The output signal of frame formatter 113 is spread by spreader 114, modulated by modulator 115, amplified by amplifier 116 and transmitted from antenna 118 via duplexer 117. The amplification factor of amplifier 116 is controlled by incrementing/decrementing the offset value of offset adjuster 135 to which a value obtained by integrator 119 integrating TPC_DBA which was extracted by RAKE combiner 123, based on the quality of the uplink signal estimated by SIR measurer 122.

[0046]

To be more specific, if the quality of the uplink signal is not good, that is, if the output value of SIR measurer 122 is low, offset adjuster 135 determines that mobile station M is far from base station A and reduces the offset value to reduce the transmission power. On the contrary, if the quality of the uplink signal is good, that is, if the output value of SIR measurer 122 is high,

offset adjuster 135 determines that mobile station M is near base station A and increases the offset value.

[0047]

The SIR measured value used for offset adjustment is averaged to a certain degree so that it does not respond to instantaneous variations. Control over instantaneous variations is more effective than using the integration result of integrator 119 to which downlink transmission power control signal TPC_DBA is input. This downlink transmission power control signal TPC_DBA is obtained by demodulating TPC_DM inserted to the uplink signal by the mobile station. This is how base station A performs downlink transmission power control. On the other hand, base station B separates the signal received from antenna 129 by duplexer 128, demodulates by demodulator 131, subjects to signal processing by despreader 132 and RAKE combiner 134 and obtains reception signal RX_DATA_UB. At this time, SIR measurer 133 estimates the reception quality of the uplink signal using the output of RAKE combiner 134 and determines the transmission power control signal of the uplink signal based on estimated value TPC_UBB. The determined transmission power control signal is inserted into downlink transmission signal TX_DATA_D as a transmission power control bit by frame formatter 124. As in the case of base station A, the output signal from the frame formatter is spread by spreader 125, modulated by modulator 126, amplified by amplifier 127 and transmitted

from antenna 129 via duplexer 128. The amplification factor of amplifier 127 is controlled, as in the case of base station A, by RAKE combiner 134, integrator 130 and SIR measurer 133, etc. An increment/decrement of offset values of offset adjuster 136 of base station B is also controlled in the same way as for base station A above.

[0048]

If the quality of the uplink signal is not good, that is, if the output value of SIR measurer 122 is low, offset adjuster 136 determines that mobile station M is far from base station B and reduces the offset value to reduce the transmission power. On the contrary, if the quality of the uplink signal is good, that is, if the output value of SIR measurer 122 is high, offset adjuster 136 determines that mobile station M is near base station B and increases the offset value.

[0049]

The SIR measured value used for offset adjustment is averaged to a certain degree so that it does not respond to instantaneous variations. Control over instantaneous variations is more effective than using the integration result of integrator 119 to which downlink transmission power control signal TPC_DBA is input. This downlink transmission power control signal TPC_DBA is obtained by demodulating TPC_DM inserted to the uplink signal by the mobile station. That is, drastic transmission power variations can be suppressed by

incrementing/decrementing the previous transmission power by 1 dB according to transmission power control signal TPC_DBA. This is how base station A performs downlink transmission power control. If there are no demodulation errors, TPC_DBA matches TPC_DBB, and the output of integrator 119 of base station A would originally match the output of integrator 130 of base station B. However, the amplification factor of the downlink signal of the amplifier of base station A and the amplification factor of the downlink signal of the amplifier of base station B are set to different values by the above control of offset adjusters 135 and 136.

[0050]

Offset adjusters 135 and 136 above have a configuration in which values of the uplink signal measured by SIR measurers 122 and 133 or those values converted by a table, etc. and then optimized are added to the outputs of integrators 119 and 130. This allows not only transmission power control common to all base stations using the TPC bit inserted into the uplink signal but also power control specific to each base station according to its distance from the mobile station. The table used for conversion of SIR measurement results are created by obtaining through simulation an optimum conversion function that will minimize the total transmission power of the system. Furthermore, offset adjusters 135 and 136 can multiply the outputs of integrators 119 and 130 by the results of SIR measurements,

etc. instead of adding the results of SIR measurements to the outputs of integrators 119 and 130. Offset adjusters 135 and 136 can also perform some linear processing or non-linear processing on the outputs of integrators 119 and 130 based on the SIR values.

[0051]

On the other hand, mobile station M receives the signal whose transmission power has been controlled as shown above from antenna 106, separates by duplexer 105, demodulates by demodulator 108, subjects it to signal processing by despreader 109 and RAKE combiner 110 and obtains reception signal RX_DATA_D. SIR measurer 111 estimates the quality of the downlink reception signal using the output of RAKE combiner 110 and determines downlink transmission power control signal TPC_DM to be inserted into the uplink signal based on the estimated quality of the downlink reception signal. This is how downlink transmission power control is performed.

[0052]

Mobile station M further extracts the uplink transmission power control signal inserted into the downlink signal from the output of RAKE combiner 110. Uplink transmission power control signal TPC_UMA is obtained by extracting control signal TPC_UBA inserted by base station A from the downlink signal. Uplink transmission power control signal TPC_UMB is obtained by extracting control signal TPC_UBB inserted by base station B from the downlink signal.

[0053]

Uplink transmission power control signals TPC_UMA and TPC_UMB received from base station A and base station B, respectively have different values. Mobile station M carries out transmission power control to increase the transmission power of the uplink signal through AND operator 112 only when both control signals TPC_UMA and TPC_UMB have control to increase the transmission power. Otherwise, mobile station M determines control value TPC_UM so that the transmission power of the uplink signal is decreased. Therefore, at the beginning or at the end of soft handover control, transmission power control of the farther base station becomes dominant, which prevents the uplink signal from the mobile station from having excessive transmission power.

[0054]

As described above, since it is possible to execute downlink transmission power control based on reception quality of uplink signal in every base station due to offset adjusters 135 and 136, the most effective transmission in transmission power becomes possible, thus it is possible to reduce total transmission power of the system, whereby it is possible to improve capacity of the system and transmission quality.

[0055]

In FIG.2, transmission power T1 (CPC_TA) and transmission power T2 (CPC_TB) represent transmission powers when base station A and base station B carry out

transmission power control according to the conventional method. In this case, less contribution of the combination by the mobile station is observed on the right side of transmission power T1 and left side of transmission power T2 despite the great power with which signals were sent.

[0056]

On the contrary, base station A and base station B carry out transmission power control above using offset adjusters 135 and 136. As a result, transmission power T1″ of base station A and transmission power T2″ of base station B decrease greatly at either the beginning or the end of a handover. Due to a drop of transmission power of either base station, the total transmission power of the system as a whole decreases.

[0057]

As illustrated in FIG.3, by using such transmission power control, in base stations A and B, although total transmission power is reduced as illustrated in FIG.2, in which the reception power combining these signals: reception power R1″ and reception power R2″ received from base stations A and B is shown as reception power R3″ (PPC_RC), reception power R3″ at the mobile station has a uniform required quality as the reception power R3′ (CPC.RC) that is combined value at the mobile station when executing conventional transmission power control.

[0058]

(Embodiment 2)

A transmission/reception apparatus according to Embodiment 2 of the present invention is explained below with reference to the attached drawings. FIG.4 are block diagrams showing an outlined configuration of a system including a transmission/reception apparatus according to Embodiment 2 of the present invention.

[0059]

The configuration of the CDMA base station according to Embodiment 2 is basically the same as that of the transmission/reception apparatus in Embodiment 1, and therefore the same components are assigned the same numbers and their explanations are omitted. The difference from Embodiment 1 is that base stations A and B are provided with reception power measurers 401 and 402, respectively. The transmission/reception apparatus according to Embodiment 2 carries out measurements of the level of reception signals from a mobile station at the base stations not by SIR measurers but by reception power measurers 401 and 402. Reception power measurers 401 and 402 adjust the level of offset values of offset adjusters 135 and 136 according to these measurement results.

[0060]

That is, the amplification factor of downlink transmission signal TX_DATA_D is controlled by a value obtained by integrators 119 and 130 integrating transmission power control signal TPC_DBA which was extracted by RAKE combiners 123 and 134 and the reception

power values of the uplink signal measured by reception power measurers 401 and 402.

[0061]

If the reception power of the uplink signal measured by reception power measurers 401 and 402 is small, mobile station M is judged to be far form base station A. In this case, base stations A and B reduce the offset values of offset adjusters 135 and 136 to reduce the amplification factor of amplifier 116, reducing the transmission power. On the contrary, if the reception power is large, mobile station M is judged to be near base station A and base stations A and B increase the offset values to increase the transmission power.

[0062]

The reception power measured values used for offset adjustment are averaged to a certain degree so that they do not respond to instantaneous variations. Control over the instantaneous variations has great effect when using result of integrators 119 and 130 integrating transmission power control signal TPC_DBA, namely, control over instantaneous variations can be performed by suppressing drastic variations of the transmission power by incrementing/decrementing the previous transmission power by 1 dB according to transmission power control signal TPC_DBA received.

[0063]

Thus, the base stations can perform more accurate downlink transmission power control through control by

the transmission power control signal received and offset control based on the reception power values measured by reception power measurers 401 and 402, transmission with the most effective transmission power becomes possible, since it is possible to reduce total transmission power, thus it is possible to improve system capacity and transmission quality.

[0064]

(Embodiment 3)

A transmission/reception apparatus according to Embodiment 3 of the present invention is explained below with reference to the attached drawings. FIG.5 are block diagrams showing an outlined configuration of a system including a transmission/reception apparatus according to Embodiment 3 of the present invention.

[0065]

The configuration of the CDMA base station according to Embodiment 3 is basically the same as that of the transmission/reception apparatus in Embodiment 1, and therefore the same components are assigned the same numbers and their explanations are omitted. The difference from Embodiment 1 is that base stations A and B are provided with time difference measurers 501 and 502, respectively. The transmission/reception apparatus according to Embodiment 3 carries out measurements of the level of reception signals from a mobile station at base stations not by SIR measurers but by time difference measurers 501 and 502. Time difference

measurers 501 and 502 adjust the level of offset values of offset adjusters 135 and 136 according to the measurement results.

[0066]

Transmission/reception operation among mobile station M, base station A and base station B is the same as that of the embodiment 1. Different point is that the amplification factor of downlink transmission signal TX_DATA_D is controlled by both a value obtained by integrators 119 and 130 integrating transmission power control signal TPC_DBA which was extracted by RAKE combiners 123 and 134 and the time difference measured by time difference measurers 501 and 502.

[0067]

Specifically, the amplification factor of downlink transmission signal TX_DATA_D is controlled by both a value obtained by integrators 119 and 130 integrating transmission power control signal TPC_DBA which was extracted by RAKE combiners 123 and 134 and the time difference between the downlink signal transmission timing and the uplink signal reception timing measured by time difference measurers 501 and 502.

[0068]

If the time difference measured by time difference measurers 501 and 502 is large, mobile station M is judged to be far form base station A. In this case, base stations A and B reduce the offset values of offset adjusters 135 and 136 to reduce the amplification factor of amplifier

116, reducing the transmission power. On the contrary, if the time difference is small, mobile station M is judged to be near base station A and base stations A and B increase the offset values to increase the transmission power. The time difference measured values used for offset adjustment are averaged to a certain degree so that they do not respond to instantaneous variations.

[0069]

As shown above, the base stations can perform more accurate downlink transmission power control through control by the transmission power control signal received and offset control based on the time difference between the transmission and receptions signals measured by time difference measurers 501 and 502 in addition to control by using offset adjusters 135, 136.

[0070]

[Effect of the Invention]

According to the present invention, the reception quality of the mobile station is maintained effectively, and preventing signals from being transmitted with excessive transmission power during a soft handover. Moreover, the total transmission power of the system decreases, whereas the system capacity and transmission quality increase.

[BRIEF DESCRIPTION OF DRAWINGS]

[FIG.1] An outlined block diagrams of a transmission/reception apparatus according to Embodiment 1 of the present invention.

[FIG.2] A schematic diagram of transmission power of the base station according to Embodiment 1.

[FIG.3] A schematic diagram of reception power of the mobile station according to Embodiment 1.

[FIG.4] Outlined block diagrams of a CDMA base station according to Embodiment 2 of the present invention.

[FIG.5] Outlined block diagrams of a CDMA base station according to Embodiment 3 of the present invention.

[FIG.6] Outlined block diagrams of a conventional example of CDMA base station.

[FIG.7] A drawing showing how a handover takes place in the conventional example of CDMA base station.

[FIG.8] A schematic diagram of reception power of a mobile station of the conventional example of CDMA base station without transmission power control.

[FIG.9] A schematic diagram of reception power of the mobile station of the conventional example with transmission power control.

[FIG.10] A schematic diagram of transmission power of the base station of the conventional example with transmission power control.

[Description of the Symbols]

116 Base station A amplifier

119 Base station A integrator

122 Base station A_SIR measurer

123 Base station A_RAKE combiner

127 Base station B amplifier

130 Base station B integrator

133 Base station B_SIR measurer

134 Base station B_RAKE combiner

135 Base station A offset adjuster

136 Base station B offset adjuster

401 Base station A reception power measure

402 Base station B reception power measures

501 Base station A time difference measurer

502 Base station B time difference measurer

[NAME OF DOCUMENT] ABSTRACT

[Abstract]

[Object] It is an object to reduce total transmission power of system while maintaining reception quality of reception station effectively and to improve capacity of system without executing transmission with excessive transmission power at the time of executing soft handover.

[Overcoming Means] The base station extracts a transmission power control signal mixed into an uplink reception signal and performs first transmission power control by amplifiers 116 and 127. At the same time, the base stations estimates the reception quality of the uplink reception signal by SIR measurers 122 and 133, and performs second transmission power control by adjusting the offset values of amplifiers 116 and 127 by offset adjusters 135 and 136 according to the estimation result. The second transmission power control is performed so as to reduce the transmission power when the base station is far from the mobile station and increase the transmission power when the base station is near the mobile station.

[Selected Drawings] FIG.1

[FIG.1]

BASE STATION A

117 DUPLEXER

116 AMPLIFIER

115 MODULATOR

114 SPREADER

113 FRAME FORMATTER

135 OFFSET ADJUSTER

119 INTEGRATOR

122 SIR MEASURER

120 DEMODULATOR

121 DESPREADER

123 RAKE COMBINER

MOBILE STATION M

101 FRAME FORMATTER

102 SPREADER

103 MODULATOR

104 AMPLIFIER

105 DUPLEXER

111 SIR MEASURER

112 AND

107 INTEGRATOR

110 RAKE COMBINER

109 DESPREADER

108 DEMODULATOR

BASE STATION B

128 DUPLEXER

127 AMPLIFIER

126 MODULATOR

125 SPREADER

124 FRAME FORMATTER

136 OFFSET ADJUSTER

130 INTEGRATOR

133 SIR MEASURER

131 DEMODULATOR

132 DESPREADER

134 RAKE COMBINER

[FIG.2]

BASE STATION TRANSMISSION POWER WITH TRANSMISSION POWER CONTROL

BASE STATION B

BASE STATION A

TIME

[FIG.3]

MS RECEPTION POWER

DESIRED QUALITY

TIME

[FIG.4]

BASE STATION A

117 DUPLEXER

116 AMPLIFIER

115 MODULATOR

114 SPREADER

113 FRAME FORMATTER

135 OFFSET ADJUSTER

119 INTEGRATOR

401 RECEPTION POWER MEASURER

122 SIR MEASURER

120 DEMODULATOR

121 DESPREADER

123 RAKE COMBINER

MOBILE STATION M

101 FRAME FORMATTER

102 SPREADER

103 MODULATOR

104 AMPLIFIER

105 DUPLEXER

111 SIR MEASURER

112 AND

107 INTEGRATOR

110 RAKE COMBINER

109 DESPREADER

108 DEMODULATOR

BASE STATION B

128 DUPLEXER

127 AMPLIFIER

126 MODULATOR

125 SPREADER

124 FRAME FORMATTER

136 OFFSET ADJUSTER

130 INTEGRATOR

402 RECEPTION POWER MEASURER

133 SIR MEASURER

131 DEMODULATOR

132 DESPREADER

134 RAKE COMBINER

[FIG.5]

BASE STATION A

117 DUPLEXER

116 AMPLIFIER

115 MODULATOR

114 SPREADER

113 FRAME FORMATTER

135 OFFSET ADJUSTER

119 INTEGRATOR

501 TIME DIFFERENCE MEASURER

122 SIR MEASURER

120 DEMODULATOR

121 DESPREADER

123 RAKE COMBINER

MOBILE STATION M

101 FRAME FORMATTER

102 SPREADER

103 MODULATOR

104 AMPLIFIER

105 DUPLEXER

111 SIR MEASURER

112 AND

107 INTEGRATOR

110 RAKE COMBINER

109 DESPREADER

108 DEMODULATOR

BASE STATION B

128 DUPLEXER

127 AMPLIFIER

126 MODULATOR

125 SPREADER

124 FRAME FORMATTER

136 OFFSET ADJUSTER

130 INTEGRATOR

502 TIME DIFFERENCE MEASURER

133 SIR MEASURER

131 DEMODULATOR

132 DESPREADER

134 RAKE COMBINER

[FIG.6]

BASE STATION A

17 DUPLEXER

16 AMPLIFIER

15 MODULATOR

14 SPREADER

13 FRAME FORMATTER

19 INTEGRATOR

22 SIR MEASURER

20 DEMODULATOR

21 DESPREADER

23 RAKE COMBINER

MOBILE STATION M

1 FRAME FORMATTER

2 SPREADER

3 MODULATOR

4 AMPLIFIER

5 DUPLEXER

11 SIR MEASURER

12 AND

7 INTEGRATOR

10 RAKE COMBINER

9 DESPREADER

8 DEMODULATOR

BASE STATION B

28 DUPLEXER

27 AMPLIFIER

26 MODULATOR

25 SPREADER

24 FRAME FORMATTER

30 INTEGRATOR

33 SIR MEASURER

31 DEMODULATOR

32 DESPREADER

34 RAKE COMBINER

[FIG.7]

BASE STATION A

BASE STATION B

[FIG.8]

MS RECEPTION POWER

COMBINATION

DESIRED QUALITY

BASE STATION B

BASE STATION A

TIME

[FIG.9]

MS RECEPTION POWER

DESIRED QUALITY

TIME

[FIG.10]

BASE STATION TRANSMISSION POWER WITH TRANSMISSION POWER CONTROL

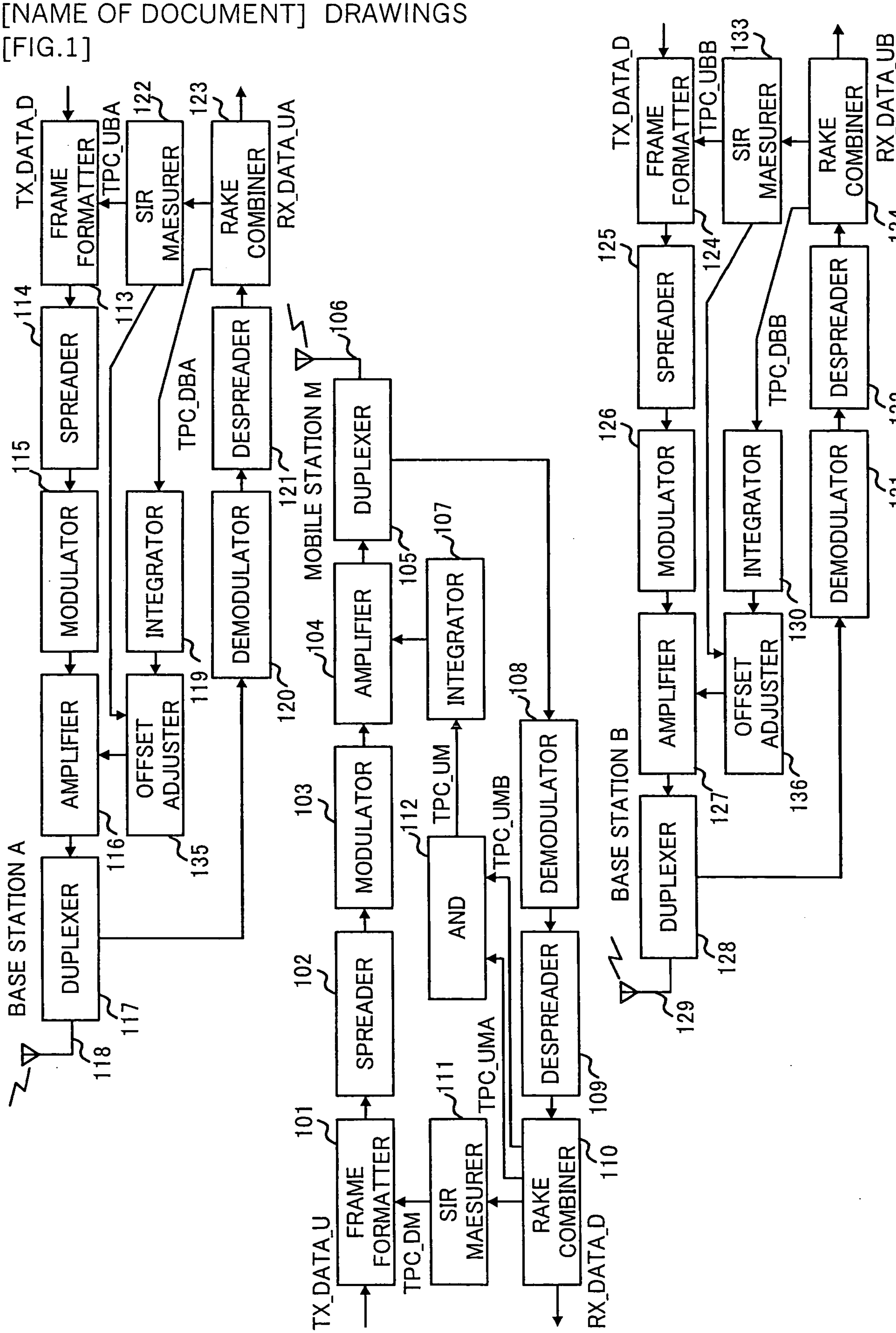
BASE STATION A

BASE STATION B

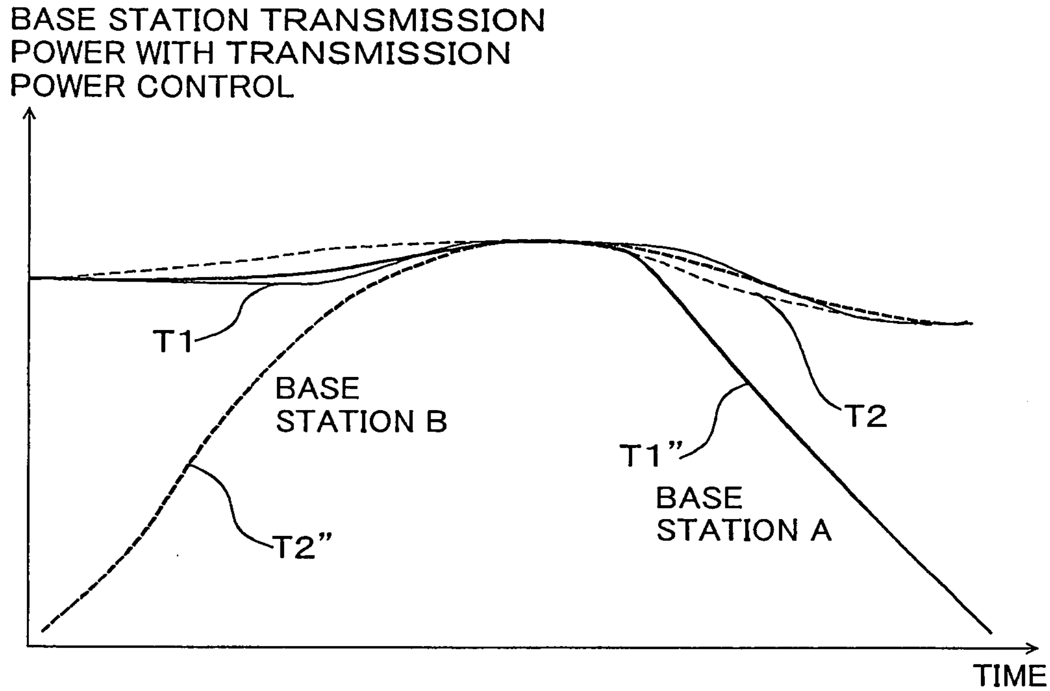
TIME

[NAME OF DOCUMENT] DRAWINGS

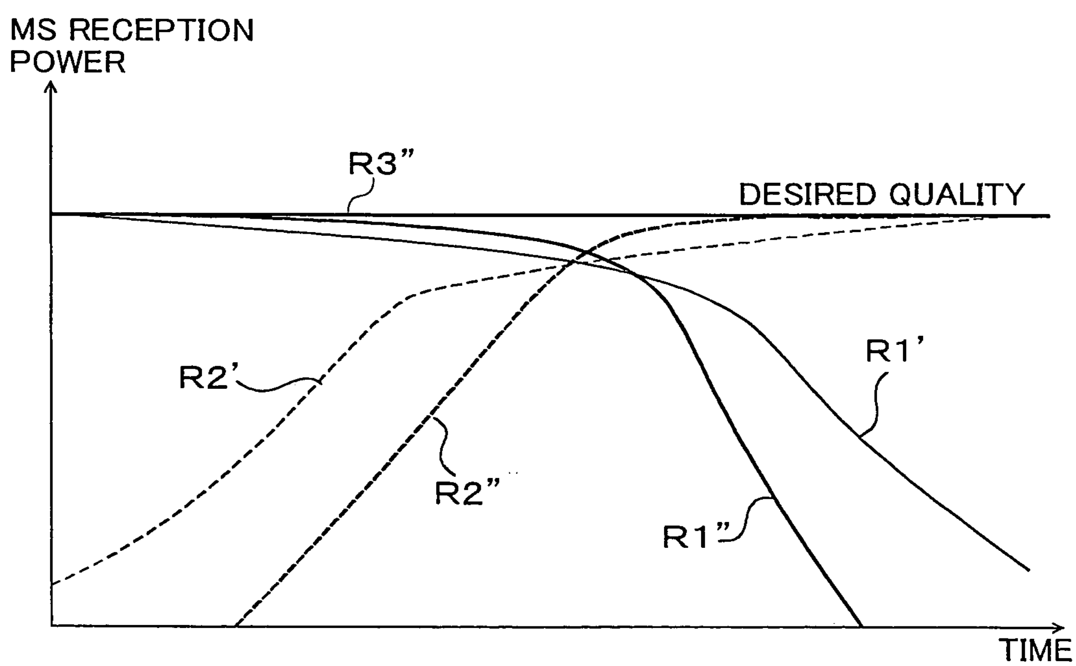
[FIG.1]



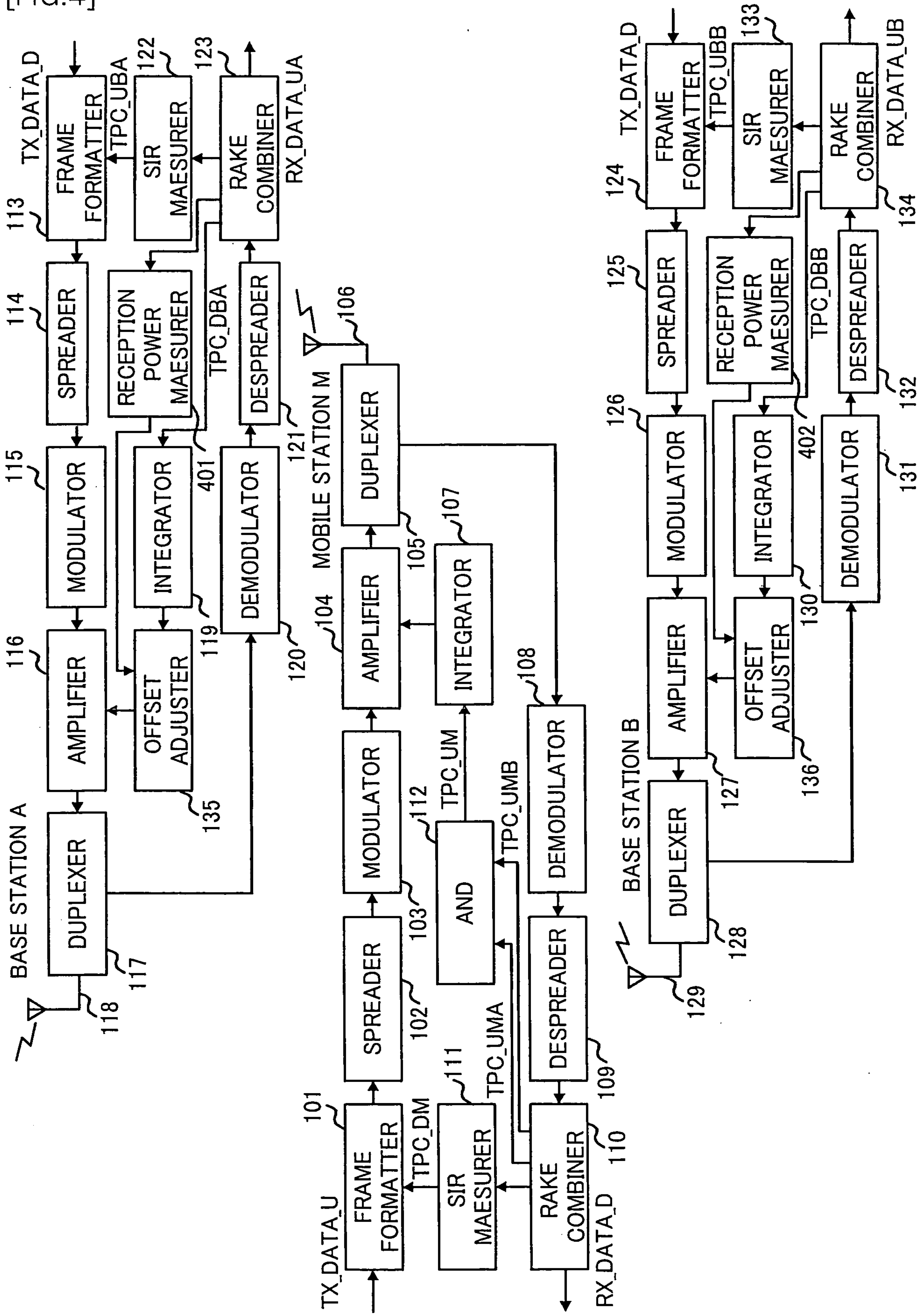
[FIG.2]


BASE STATION TRANSMISSION POWER WITH TRANSMISSION POWER CONTROL
T1
BASE STATION B
T2
T1"
BASE STATION A
T2"
TIME

[FIG.3]

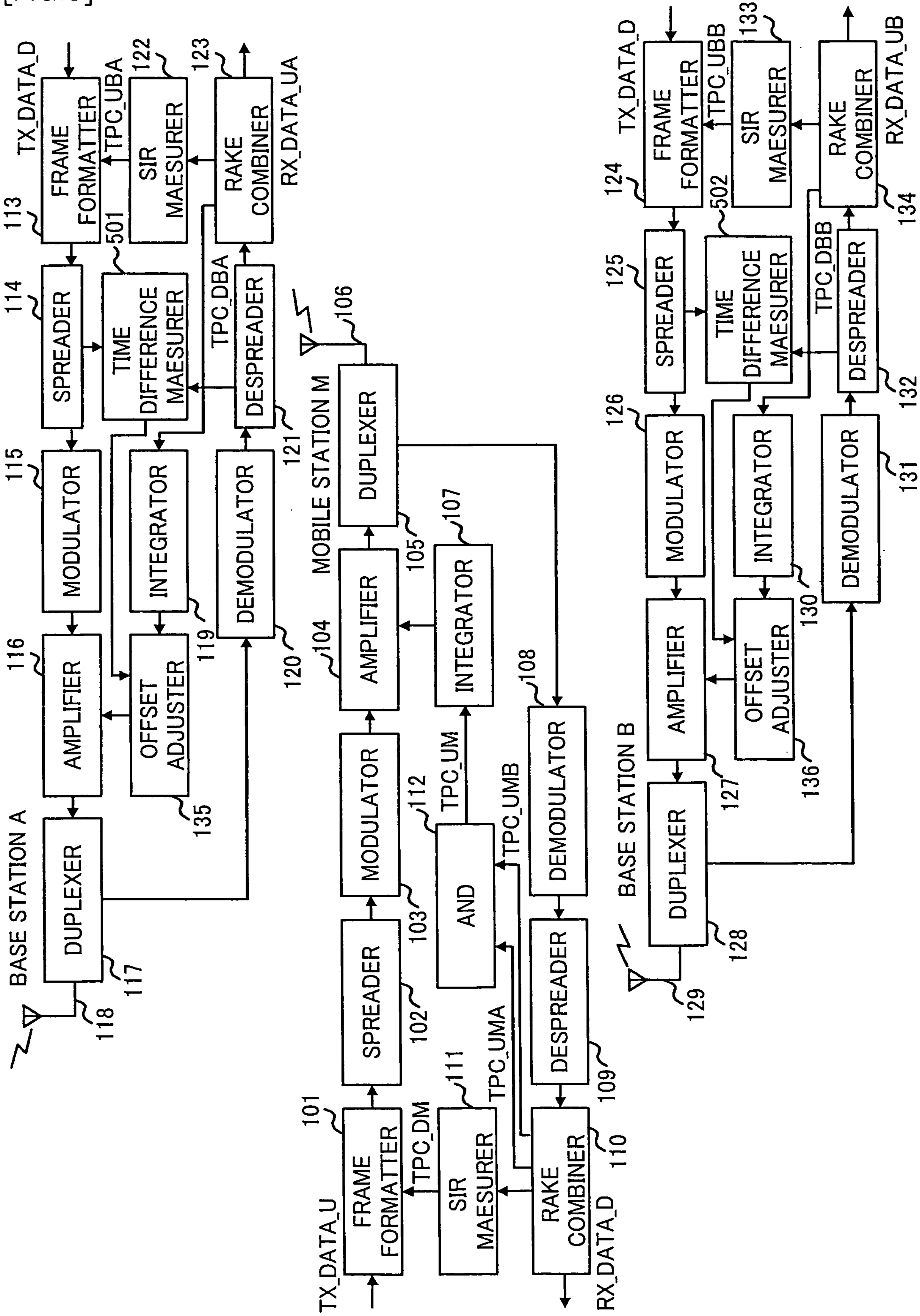

MS RECEPTION POWER
R3"
DESIRED QUALITY
R1'
R2'
R2"
R1"
TIME

[FIG.4]

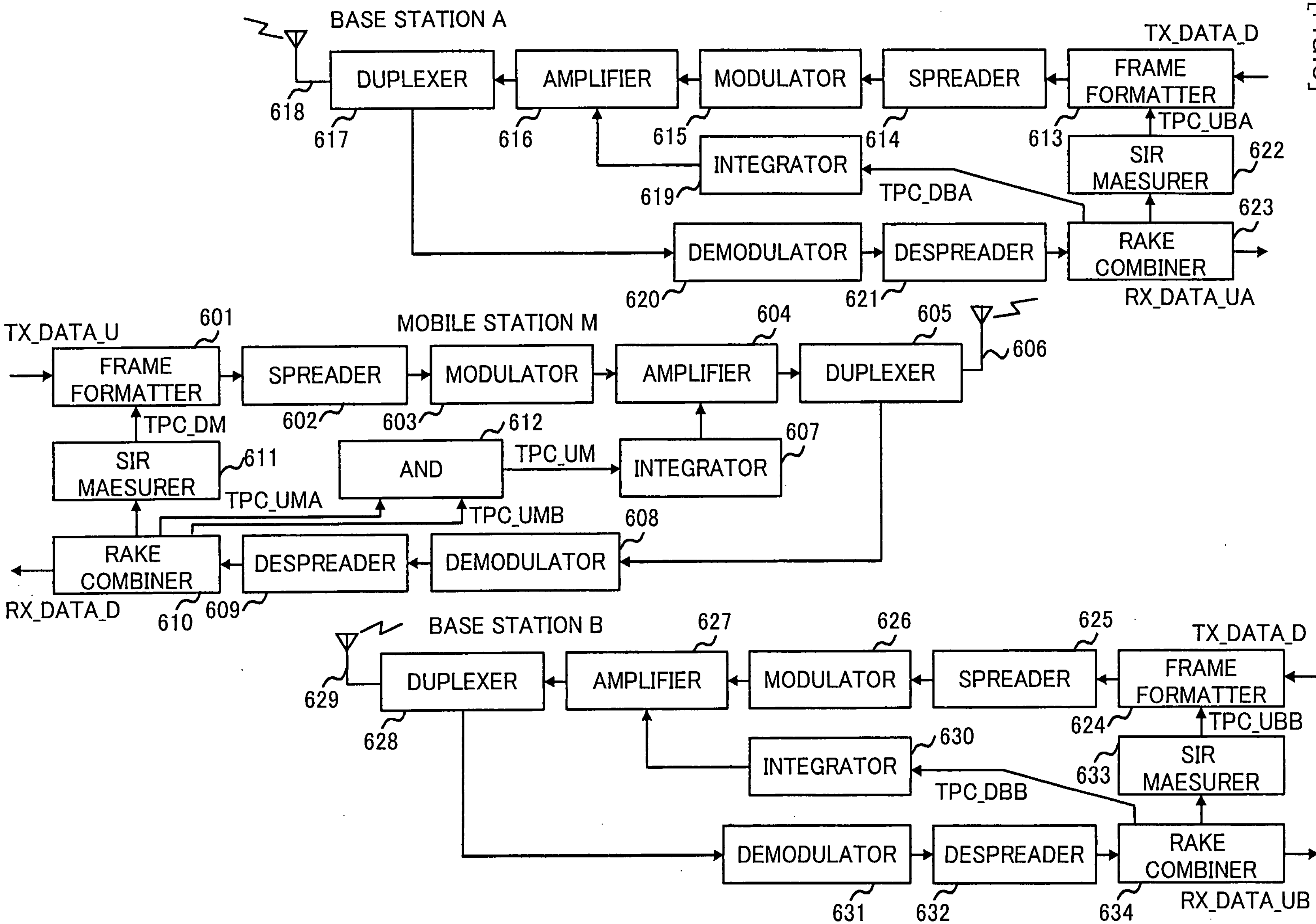


BASE STATION A
TX_DATA_D
FRAME FORMATTER
113
SPREADER
114
MODULATOR
115
AMPLIFIER
116
DUPLEXER
117
118
TPC_UBA
SIR MAESURER
122
RECEPTION POWER MAESURER
401
INTEGRATOR
119
OFFSET ADJUSTER
135
RAKE COMBINER
123
RX_DATA_UA
TPC_DBA
DESPREADER
121
DEMODULATOR
120
MOBILE STATION M
106
DUPLEXER
105
AMPLIFIER
104
INTEGRATOR
107
MODULATOR
103
SPREADER
102
FRAME FORMATTER
101
TX_DATA_U
TPC_UM
AND
112
TPC_UMB
TPC_UMA
SIR MAESURER
111
TPC_DM
DEMODULATOR
108
DESPREADER
109
RAKE COMBINER
110
RX_DATA_D
BASE STATION B
TX_DATA_D
FRAME FORMATTER
124
TPC_UBB
SIR MAESURER
133
RAKE COMBINER
134
RX_DATA_UB
SPREADER
125
RECEPTION POWER MAESURER
402
TPC_DBB
DESPREADER
132
MODULATOR
126
INTEGRATOR
130
DEMODULATOR
131
AMPLIFIER
127
OFFSET ADJUSTER
136
DUPLEXER
128
129

[FIG.5]

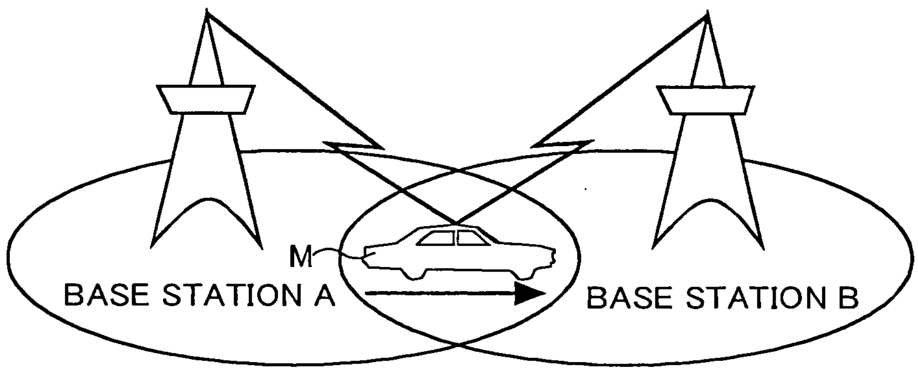

BASE STATION A
TX_DATA_D
FRAME FORMATTER
113
TPC_UBA
SIR MAESURER
122
RAKE COMBINER
123
RX_DATA_UA
SPREADER
114
TIME DIFFERENCE MAESURER
501
TPC_DBA
DESPREADER
121
MODULATOR
115
INTEGRATOR
119
DEMODULATOR
120
AMPLIFIER
116
OFFSET ADJUSTER
135
DUPLEXER
117
118
MOBILE STATION M
DUPLEXER
106
105
AMPLIFIER
104
INTEGRATOR
107
MODULATOR
103
AND
112
TPC_UM
TPC_UMB
DEMODULATOR
108
SPREADER
102
DESPREADER
109
FRAME FORMATTER
101
TX_DATA_U
SIR MAESURER
111
TPC_DM
TPC_UMA
RAKE COMBINER
110
RX_DATA_D
BASE STATION B
TX_DATA_D
FRAME FORMATTER
124
TPC_UBB
SIR MAESURER
133
RAKE COMBINER
134
RX_DATA_UB
SPREADER
125
TIME DIFFERENCE MAESURER
502
TPC_DBB
DESPREADER
132
MODULATOR
126
INTEGRATOR
130
DEMODULATOR
131
AMPLIFIER
127
OFFSET ADJUSTER
136
DUPLEXER
128
129

[FIG.6]

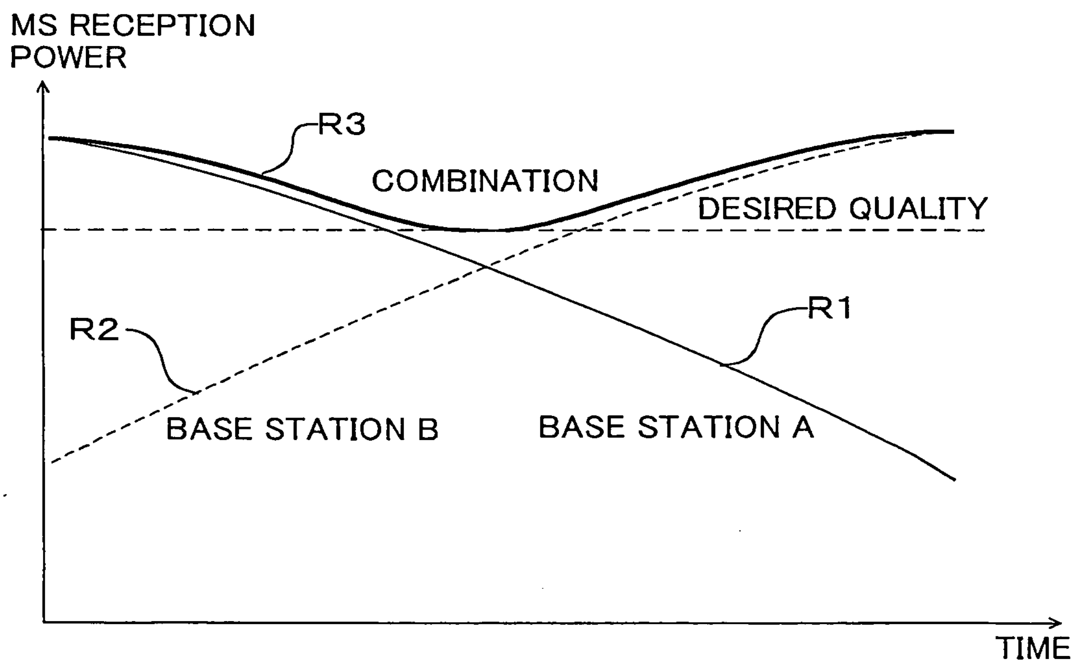


BASE STATION A
TX_DATA_D
DUPLEXER
AMPLIFIER
MODULATOR
SPREADER
FRAME FORMATTER
TPC_UBA
INTEGRATOR
SIR MAESURER
TPC_DBA
DEMODULATOR
DESPREADER
RAKE COMBINER
RX_DATA_UA
618
617
616
615
614
613
622
619
623
620
621
MOBILE STATION M
TX_DATA_U
FRAME FORMATTER
SPREADER
MODULATOR
AMPLIFIER
DUPLEXER
TPC_DM
SIR MAESURER
AND
TPC_UM
INTEGRATOR
TPC_UMA
TPC_UMB
RAKE COMBINER
DESPREADER
DEMODULATOR
RX_DATA_D
601
602
603
604
605
606
607
608
609
610
611
612
BASE STATION B
TX_DATA_D
DUPLEXER
AMPLIFIER
MODULATOR
SPREADER
FRAME FORMATTER
TPC_UBB
INTEGRATOR
SIR MAESURER
TPC_DBB
DEMODULATOR
DESPREADER
RAKE COMBINER
RX_DATA_UB
624
625
626
627
628
629
630
631
632
633
634

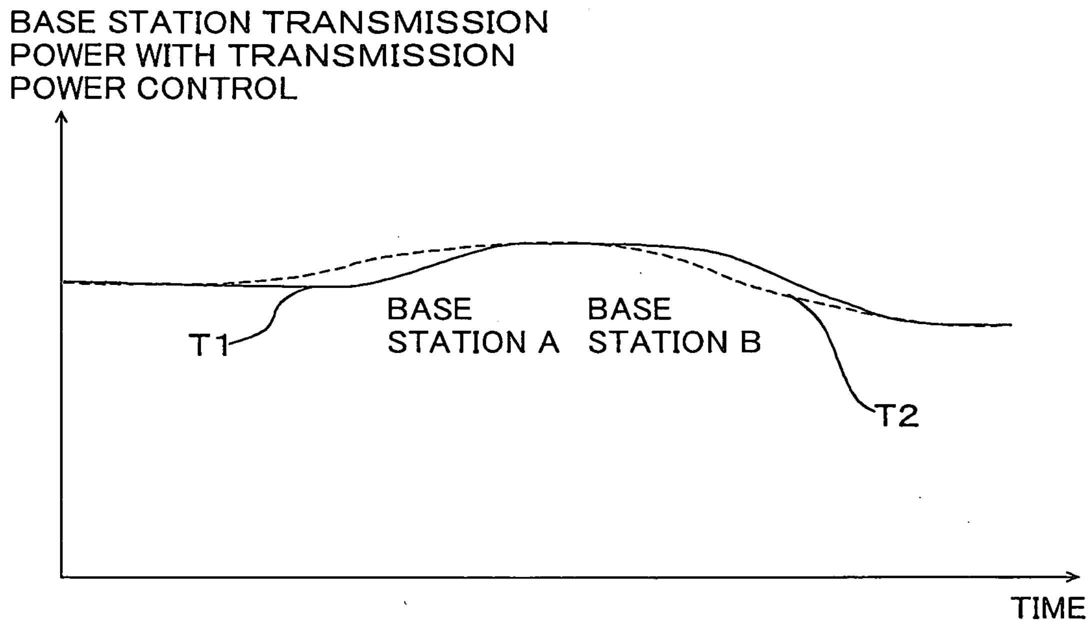
[FIG.7]


M
BASE STATION A
BASE STATION B

[FIG.8]


MS RECEPTION POWER
R3
COMBINATION
DESIRED QUALITY
R2
R1
BASE STATION B
BASE STATION A
TIME

[FIG.9]



[FIG.10]

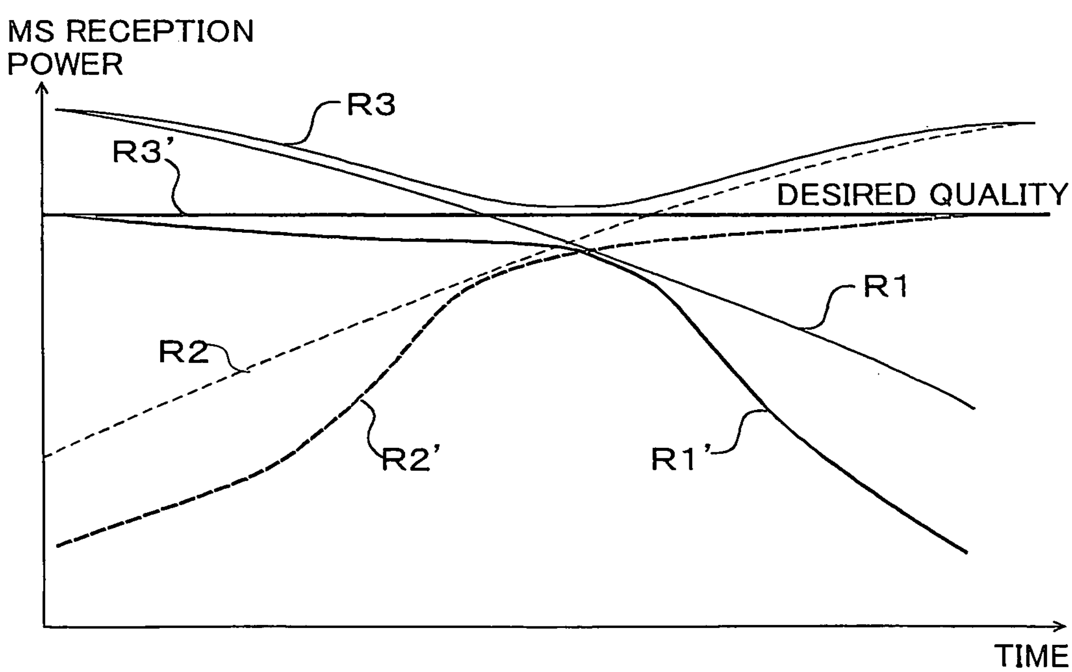


FIG.4